

Project Title
**Vertical Profiles of Latent Heating in TRMM: Validation and Assimilation in the
GEOS Data Assimilation System**

Principal Investigator: Minghua Zhang
Associate Professor and Director
Institute for Terrestrial and Planetary Atmospheres, SUNY at Stony Brook

Year 2001 Project Report

Research has been pursued both in (a) validation and (b) assimilation of the TRMM vertical heating profiles.

1. Validation: derivation of Q1 and Q2 from field experiments

I have derived the vertical profiles of apparent heating Q1 and Q2 by using 3-hourly balloon sounding data from the ARM SGP sounding array for three IOPs in 2000. These IOPs cover the periods from 3/1 to 3/22, from 9/25 to 10/8, and from 11/27 to 12/22. These heating profiles will be collocated with the TRMM heating profiles for validation studies once the TRMM profiles become available to the investigators.

I have also produced the objective analyses of Q1, Q2 and forcing fields for the international GCSS Case 3 Intercomparison project (Xu et al., QJRMS, 2001). The GSFC CRM participated in study, based on which TRMM heating profiles are derived.

2. Assimilation: constraining the spectrum of cloud base mass flux

I have studied to assimilate the vertical heating profile by constraining the cloud-base mass flux in the cumulus convection scheme using the CCM3. I first derive the vertical heating profile for each convective plume of unit cloud-base mass flux. The observed heating profile from ARM is then de-convoluted to derive the cloud base mass fluxes of all individual plumes. These fluxes are compared with those derived from the quasi-equilibrium hypothesis. They are shown to improve many other aspects of the model behavior (see slide for graphic illustration).

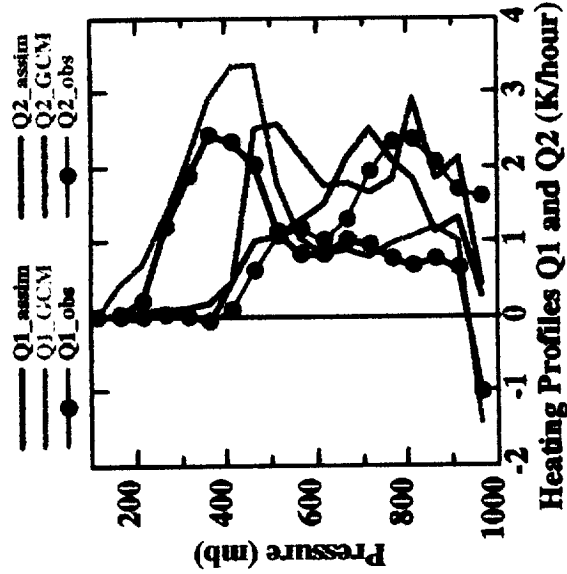
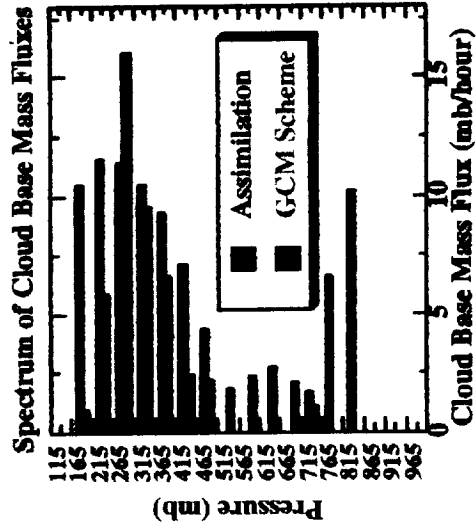
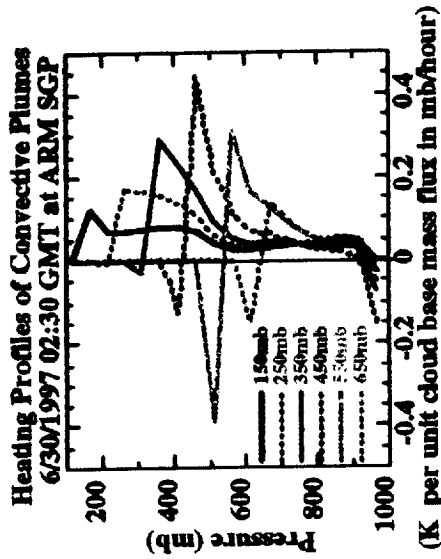
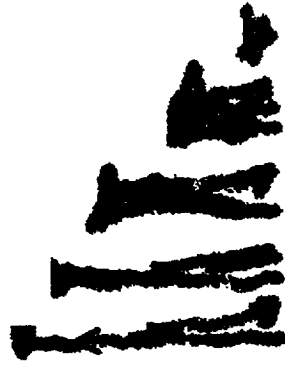
This work is still in experimental stage and I expect to work with Arthur Hou to implement it in the GEOS model in the near future.

Publications (2001)

- Zhang, M. H.**, J. L. Lin, R. T. Cederwall, J. J. Yio, and S. C. Xie, 2001: Objective analysis of the ARM IOP data: method and sensitivity. *Monthly Weather Review*, 129, 295-311.
- Zhang, M. H.**, 2001: Cloud-climate feedback: lessons learned from two El Nino events. In "Frontiers in Climate Modeling" by Kiehl and Ramanathan. In press.
- Cess, R. D., **M. H. Zhang**, B. A. Wielicki, D. F. Young, X. L. Zhou, and Y. Nikitenko, 2001: the influence of the 1998 El Nino upon cloud radiative forcing over the Pacific warm pool. *J. Climate*, 14, 2129-2137.
- Xu et al., and **M. H. Zhang**, 2001: An intercomparison of cloud-resolving models with the ARM summer 1997 IOP data. *Quarterly Journal of the Royal Meteorology Society*, in review.

Experimental Assimilation of Vertical Heating Profiles By Constraining the Spectrum of Cloud Base Mass Fluxes in the Convection Scheme

Convective Plumes



1. Vertical heating profiles from individual convective plumes per unit cloud-base mass flux are first calculated.
2. The total vertical heating profile from satellite/field measurements is then deconvoluted using these plume profiles to derive the cloud-base mass flux of each plume.
3. The derived cloud-base mass fluxes from assimilating the measured vertical heating profile are compared with those from the standard calculation of the quasi-equilibrium hypothesis. They are shown to significantly improve other aspects of the model behavior (see Q2 in the last figure).